Bovine Immunizations

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Immunization procedures provide the practicing veterinarian with a flexible dependable tool to aid in preventing or controlling disease conditions in a herd. The decision to use any vaccine in a herd is usually based on the personal preference of the owner or veterinarian. The basis, however, for an immunization program should be derived from a knowledge of disease conditions within a herd, management conditions present on the farm or ranch, and an understanding of population variances within the herd.

The first criteria for selecting vaccines to use in a herd depends upon the diseases present in the herd and on disease conditions present in the area. This allows for decisions on evaluating areas of greatest potential losses, economic factors involved in both the disease conditions and vaccination procedure, and vaccine availability to prevent the disease. This initial step is based on an accurate diagnosis or previous diagnoses. In addition, herd monitoring is important since endemic problems do develop, and the resultant production losses are often accepted as normal for the herd. Alteration of current vaccination schedules, products used, and frequency of administration may be able to correct the problem. Secondly, the program should not interfere with production objectives of the herd. An example would be the producer that anticipates exportation of purebred animals. The selection of products such as anaplasmosis vaccine or in some cases IBR vaccine may not be justified due to residual antibody activity. Therefore, alternative procedures must be employed.

The second criteria for vaccine selection relies upon a knowledge of management procedures in the herd. This includes both physical and population management. Physical management consists of working patterns in the herd, labor availability, and existing or planned facilities. Vaccination schedules should be designed around working patterns of the herd. Procedures can be designed for a once a year, twice a year, or more handling of all cattle in the herd. An example working schedule of a 4 handling system for cows and a 3 handling system for heifers is in Table 1. This particular example was designed specifically for a herd based on its current working system. This type of scheduling allows flexibility of time; however, it narrows the range of time to allow for variance in vaccines, booster vaccination, and follows a set pattern annually. If a vaccination program is established and becomes a routine part of cattle work, then definite modifications to the program's advantage can be made, e.g. adding or deleting vaccines or procedures. By scheduling work the problem of labor availability usually can be minimized.

Population management in the herd tends to be one of the biggest ongoing problems. Vaccine selection, frequency of use and type of product vary between open and closed herds. The source of new cattle will also influence vaccination procedures. Confinement operations with increased cattle density and where the likelihood of increased exposure exists, dictate differing vaccination approaches than for cattle under range conditions. Feeding practices influence vaccination procedures such as in the use of *Clostridium perfringens C* and *D* vaccines in feedlots. In a recent trial,[1] heifers fed a low energy diet (70% NRC) beginning 100 days prior to the start of the calving season, and vaccinated 45 days prior to the start of the calving season with a bacterin (Somnugen @ Bio-Ceutic Labs, St. Joseph, Mo.) produced significantly lower colostral antibody titers than did heifers fed a high energy diet (100% NRC).

Population management systems rely on categorizing cattle into 4 distinct populations: neonatal, neonatal to weaning, prebreeding heifers, and adults. Disease problems tend to occur within age populations and the reproductive status of breeding females. The selection of vaccines for these target areas allow for specificity in obtaining the most benefit from the product.

Neonatal Period

The neonatal period is one of high susceptibility to disease, and vaccines administered during this period are to protect the calf from common infectious agents that occur early in life. The ingestion of colostrum within the first few hours of birth affords the calf non-specific immunity to antigens previously exposed to the cow's immune system. The antibodies in the colostrum are absorbed into the blood circulation with maximum efficiency during the first 6 hours after birth and efficiency of absorption is rapidly reduced and almost no absorption occurs after 24 hours.[2] Specific immunity in colostrum can be enhanced through the use of maternal vaccination. Four commonly used antigens are for *Escherichia coli*, Rotavirus, Coronavirus, and *Clostridium*

Table 1

Working schedule based on a 4 handling system for the adult cows and a 3 handling system for replacement heifers per year.

A) *Cowherd*
- 1) 1st contact - Calving Season (1 Mar. - 1 May)
  - a) calf identification (tattoo and tag)
  - b) birth date recorded
- 2) 1-15 Aug. - 1st group handling
  - a) Brucella vaccination of heifer calves
  - b) treat necessary abscesses, pinkeye, foot rot, etc.
  - c) examine cows for lump jaw, cancer eye, lameness
- 3) 15 Sept. - 1 Oct. - 2nd group handling
  - a) preweaning vaccination of calves
  - b) pregnancy exam - cull open and late - calving cows
  - c) examine cowherd - poor udders, broken mouths, carry over cows from Aug. exam
  - d) vaccination of cowherd
- 4) 1 Oct. - 15 Oct. - 3rd group handling
  - a) wean calves
  - b) booster vaccinations of calves
- 5) Jan. or Feb. - 4th group handling
  - a) lice treatment
  - b) scours vaccine - if needed in program

B) *Replacement Heifers*
- 1) 1-15 Mar. - 1st group handling
  - a) prebreeding vaccination
  - b) final prebreeding vaccination and culling
- 2) 1-15 Aug. - 2nd group handling
  - a) pregnancy exam
  - b) treat eyes, abscesses, etc.
  - c) cull open and undesirable heifers
- 3) Jan. - Feb. - 3rd group handling
  - a) treatment for lice
  - b) initiation of scour vaccination — if necessary

perfringens, type *C* and *D*. Prepartum vaccination, both primary and booster, have been shown to enhance colostral antibodies to the products. The utilization of products to prevent these conditions is based upon the presence and/or incidence of the condition, the economic value of the condition, and the availability of delivery of the product to the dam.

In cattle, the primary enteropathogenic *E. coli* appears to possess the K99 pili antigen,[3] however, 987P pili antigen has also been reported to cause an enteric condition in neonatal calves.[4] *E. coli* immunization using the K99 antigen should be administered in 2 doses, 6 and 3 weeks pre-calving.

Immunization of the dam for rota and corona viruses is based on a primary series consisting of two injections. The timing of the first injection can be as far as 5-6 months pre-calving, such as, when the cattle are processed in the fall of the year for a spring calving cowherd, to approximately 30 days pre-calving. The second injection may by utilized ahead of the calving season by 2 weeks. Annual revaccination should occur ahead of calving as a single injection.

In herds where *Clostridium perfringens* type C hemorrhagic necrotic enteritis is a problem, prepartum vaccination is beneficial. *Cl. perfringens* type C produces both alpha and beta toxins with beta toxin being responsible for the hemorrhagic lesions in the intestine. The use of a bacterin/toxoid prior to the start of the calving season is recommended. A two-injection system may be employed with the first injection being administered at the time of fall working and the booster injection given immediately prior to calving.

Neonatal to Weaning Period

This period is characterized by incomplete maternal antibody protection, increased stress, and increased exposure to potential pathogens. Passive immunity derived from maternal antibodies begins to decline, thus increasing the susceptibility of the young calf.

Demonstrable protective antibodies vary in calves from as little as 4 weeks with *Clostridium chauvoei* to up to 8 months for Bovine Viral Diarrhea virus. The level of actual protection, percentage of calves protected, and time to the disappearance of antibodies vary between individuals and between herds. These acquired antibodies should not be depended upon for complete protection in the herd. Infectious Bovine Rhinotracheitis[5] and myxovirus parainfluenza-3[6] vaccines have been demonstrated to provide protection and decrease the severity of subsequent infection, even in the presence of maternal antibody. In situations practicing early calf vaccination, the initial vaccination should be followed with a booster vaccination 3 weeks prior to or at weaning.

Vaccination during this period should provide protection throughout the postweaning period. Post-challenge resistant seems to be maintained following the use of intranasal IBR/PI_3 vaccine for up to 9 months[7] and for a greater length of time following intramuscular vaccination for IBR and BVD.[8] Approximately 2-5% of vaccinated cattle will not become serologically positive when vaccinated with BVD vaccine.[9] Calves showing a BVD titer of approximately 1:16 or greater apparently have enough antibody systemically and locally to suppress viral replication,[10] however, a 1:8 level may be sufficient. It has been advocated that *Clostridium perfringens* vaccines be repeated at 60 days postvaccination in animals maintained on high energy diets[11] due to the increased incidence of clinical cases of *clostridium perfringens* late in feeding periods.

Protection of the calf from potential pathogens around the time of weaning appears to be most complete following

preweaning vaccination procedures. The results of a trial (Table 2) conducted in 1980 show a marked advantage to preweaning vaccination. In this trial, calves were initially immunized one month prior to weaning, with booster vaccinations administered at weaning. Control calves were vaccinated with identical products at weaning with no booster immunizations. Even when preweaning vaccinations are practiced, calves that responded to primary vaccinations as evidenced by circulating antibody titer may still become infected with IBR and PI_3 virus.[6] Following vaccinations, challenged animals appear to have significant increase in titer activity by 14 days.[7]

Table 2. Summary of 1980 Preweaning Vaccination Trials (Kansas State University)

	Control[1]	Preconditioned[2]
Total No. of animals	337	299
Respiratory Cases	16	0
Death loss	1	0

[1]*vaccinated at weaning using intramuscular IBR vaccine, Clostridium chauvoei and septicum, Pasterurella multocidia and hemolyticium, and dewormed*

[2]*vaccinated one month prior to weaning using products outlined above, booster of Pasteurella vaccine at weaning*

Prebreeding Period

A prebreeding vaccination program of 10-12 month-old heifers with subsequent breeding at 13-16 months of age is used to develop initial herd protection in a group of animals that should be ideal candidates for maximal response, e.g. non-stressed, positive plane nutrition, and non-pregnant. The basic objectives in prebreeding immunizations are to protect the first pregnancy, establish a level of immunity that can be carried into adulthood, and to avoid recognized vaccine side-effects. Developing a comprehensive program for replacement heifers precludes the extensive use of viral vaccines in the adult cowherd.

Prebreeding heifer vaccinations using viral vaccines allows the introduction of a high percentage of seropositive animals into the cowherd annually. Due to the persistence of protective antibody titers in most animals this may enhance collective herd immunity. Work with the BVD virus indicates that a dam's titer of 1:32 or higher will protect the fetus when the dam is experimentally exposed during any stage of gestation,[12] however, low conception rates post-exposure may not improve until titers have reacher 1:128 when bred to bulls excreting the virus in semen.[13]

Viral vaccination may not confer life time protection in all animals. The use of intramuscular IBR vaccine can result in humoral immune responses that persists 3-6 years following vaccinations.[14] Intranasal vaccination appears to offer protection to reproductive effects of IBR for at least the period of pregnancy.[15] Using a single strain of BVD vaccine provides good long-term immunity. Protection against other strains is good initially but will decrease over time.

The incorporation of these products into a prebreeding program appears to provide long-term immunity and protects the first pregnancy. This will allow the use of these products 30-45 days prior to initial breeding without the undue side-effects of potential abortion and transient infertility. In a cowherd using a 60-day breeding season the time span from the end of the calving season to the start of the breeding season is usually 20 days in length. Trying to follow recommended procedures of not using viral vaccines within 30 days of breeding, the introduction of these products into an adult program is difficult at best. In a recent study, [16] no effects on conception or rebreeding were observed in a cowherd using annual intranasal IBR and intramuscular BVD vaccination procedures from less than 2 weeks and further postpartum.

The development of inapparent carriers with prolonged shedding of leptospiral organisms and the potential for constant exposure from other domestic animals and wildlife populations necessitates the use of leptospiral vaccines in all prebreeding and breeding programs. Following prebreeding vaccinations, annual boosters should be used which will stimulate protective antibodies in individual animals and build up herd immunity. Serovars in the product used should coincide with reported serovars in your area. Little evidence of cross protection from one serovar to another exists. The use of multivalent vaccines every 6 months in open or endemic herds, and annually in closed herds, appears to be adequate.

The introduction of breeding stock into closed herds is usually through the addition of new herd bulls. Frequently, undesired breedings result from exposure to the neighbor's bull in a pasture. Since the use of artificial insemination is low in beef herds, the use of campylobacter vaccines in all breeding females provides the most practical method of control of the disease. In confinement dairy herds with a high frequency of artificial insemination, the use of semen from non-infected bulls provides absolute control of the spread of vibriosis.[17]

Protection against *Campylobacter fetus* appears to be provided by humoral antibody (lqG) which enters the lumen of the genital tract. A correlation exists between serum titer and the degree of protection.[18] Vaccines requiring booster vaccinations appear to provide protection only from antibodies produced in the response to the booster dose. In this situation the booster should be administered 10 days before the start of the breeding season so that titers will be highest during the breeding season.[19] It is generally recommended that heifers be vaccinated twice, and the booster vaccinations administered no later than 2-3 weeks prebreeding. If the herd working pattern does not lend itself to prebreeding season vaccination procedures, then the vibrio vaccinations may be incorporated into a fall working program. Vaccination and convalescent immunity decreases with the passage of time. Optimal reproduction

requires annual vaccination of all cows.[20]

Adult Period

The objectives of immunizations in this phase of a herd program are to protect against commonly occurring reproductive diseases and to maintain herd immunity to prevent epidemic diseases. The development of an effective replacement heifer immunization program and the annual use of vaccines requiring booster immunizations result in a large number of animals acquiring protective antibodies. The resistance of a portion of the animals in a herd to a disease decreases the opportunity for rapid transmission. Although infection may occur in the presence of herd immunity, the resulting disease is often non-clinical or mild due to partial protection.[21] The routine use of leptospital and campylobacter (vibrio) vaccines are needed on an annual basis in the cowherd due to their relative short duration of immunity. Immunization of bulls should be practiced at the same time as for the cowherd for both leptospirosis and vibriosis.[22]

The therapeutic use of vaccines for the control of endemic or acutely occurring vibrosis and leptospirosis may offer an additional management tool. For the control of leptospiral outbreaks the simultaneous use of a multivalent vaccine and treatment with 25 mg/kg dihydrostreptomycin causes a decrease in abortions in 1-2 weeks postvaccination and may diminish the incidence of retained fetal membranes and repeat breeding animals. In addition, it will shorten the period of leptospiral shedding and decrease the number of organisms shed.[23]

The use of vibrio vaccines will decrease or eliminate genital infections, however, genital infection may persist for up to 44 days following vaccination[24] in cows and for up to 21 days following a two-series vaccination in bulls.[25] There appears to be no correlation between the time required for the elimination of an established infection and the blood serum titer resulting from therapeutic vaccination.[18]

Recommendations for the use of anaplasmosis vaccination programs are based on both protection from clinical disease and decreasing or eliminating the incidence of neonatal isoerythrolysis. Immunization does not prevent the carrier state nor does it provide complete immunity, but it does aid in preventing clinical signs of the disease.[26] Breeding females should be vaccinated as far ahead of calving as possible, preferably while open. Single booster vaccinations should only be given every 2 years or longer. No time restrictions need to be placed on bulls.

Conclusion

A thorough vaccination program will not control all diseases that could occur in a herd. The practicing veterinarian is continuously faced with disease outbreaks or endemic conditions for which no vaccine exists. The development and management of a herd vaccination program requires a thorough knowledge of herd management practices, disease conditions present on the premises and in the general area, a basic understanding of bovine immunology, and experience and knowledge of the limitations and advantages of products being used in the program. Immunization procedures on a farm are subject to change based on alterations in disease patterns, new disease outbreaks, and the introduction and marketing of new or improved vaccines. An immunization schedule currently in use demonstrates the application of some of the guidelines outlined in this paper (Table 3).

Table 3

Example Vaccination Schedule for a Spring Calving (1 March-1 May) Cowherd

1) Calves - 1 June - 15 June
- **a) Clostridial - Chauvoei and Septicum**

2) Brucella vaccination - early Aug. - heifers only

3) Preweaning - all calves - 15 Sept. - 1 Oct.
- **a) IBR/PI_3** - intranasal
- b) BVD - IM
- c) Clostridial - chauvoei, septicum, sordellii, and novyii - subq
- d) Lepto. pomona - IM
- e) grubicide
- f) implant steers and non-replacement heifers

4) Cowherd - 15 Sept. - 1 Oct.
- a) Lepto - 5 serovars - IM
- b) Vibrio - IM
- c) lice control

5) Replacement Heifers - prebreeding - 1 Mar. - 15 Mar.
- a) IBR/BVD - IM
- b) Lepto - 5 serovars - IM
- c) Vibrio - IM
- d) Clostridial spp. - subq

e) vit. A - 2.5 million units - IM

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